§23. Spectroscopy and Atomic Modeling of EUV Light from LHD Plasmas

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i) Introduction

Radiations from high-Z elements are of great importance to understand energy balance in fusion plasmas. Such radiations also attract attention as a highly bright light source including 13.5 nm extreme ultraviolet (EUV) for use in next-generation lithography of semi-conductor devices. A lot of issues associated with atomic modeling must be addressed to realize a clean and efficient EUV source. Magnetically confined plasmas such as LHD are one of the best standard plasma sources because plasma profiles are uniform, and temperature and density profiles are well diagnosed.

This year, a new type of holographic grating was tested on LHD to acquire better spectral resolution in the EUV spectral range.

ii) EUV spectra from holographic grating spectrometer

By using a grazing incidence EUV spectrometer including a new holographic grating (so called resolution-corrected, holographic grating) was implemented in LHD, and EUV emission spectra from Fe, O and C ions in a range of 1-7 nm were observed to investigate the performance of a new type of the holographic grating spectrometer. It is noteworthy that the emission spectra in 1-2 nm from Fe ions are more finely resolved than those with the former EUV spectrometer including a first-generation holographic-grating plate. This feature is particularly important in order to observe finely-resolved spectra from W ions included in fusion plasma.

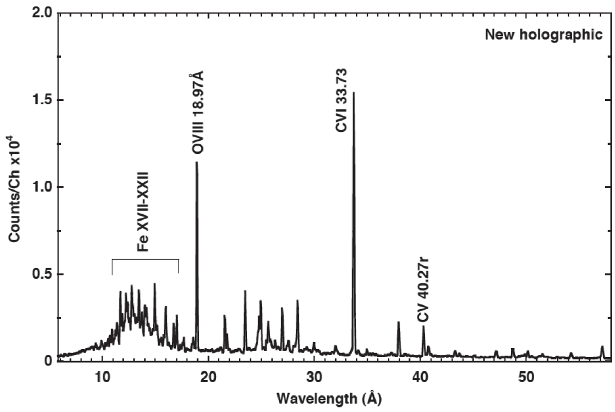

Fig. 1 EUV spectra observed from LHD plasma.

iii). Higher-order components and spectral resolution power

Influence of higher-order components on the output spectra was investigated using carbon line spectra. As shown in Fig. 2, higher order components are negligibly small as well as the result from the former-tyep holographic grating.

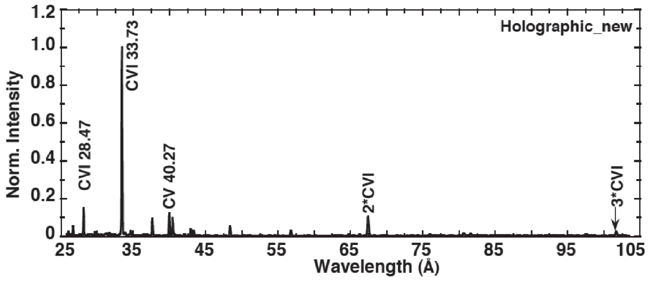

Fig. 2. Higher order components.

Comparison of spectral resolutions for ruled-grating, former holographic and new holographic gratings are shown in Fig. 3. Substantial improvement n the resolution is obtained with the new holographic grating particularly in the 1-2 nm range. In general, spectral lines do not exist closely in longer wavelength region (4-12 nm). The present resolutions therefore give a good performance for high-temperature diagnostics.

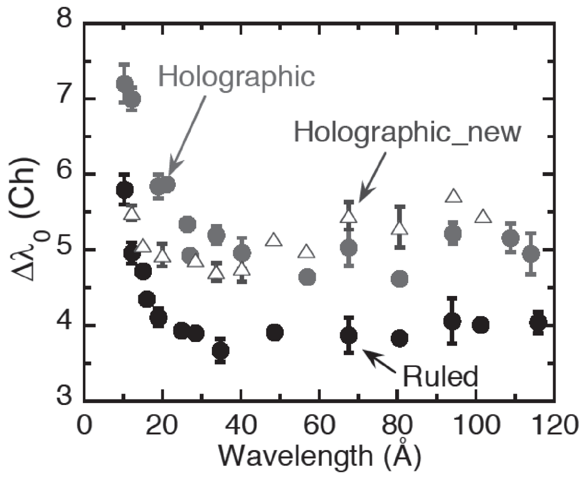

Fig. 3 Comparison of spectral resolutions among three different gratings.

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